Effective Use Of Sediment Quality Guidelines:
Technical and Regulatory Decisions

Kennecott Utah Copper

William J. Adams
Kennecott Utah Copper
Magna, Utah
Adamsw@kennecott.com


2001 8 23

$20 M Cleanup

-$10 M Construction

-$10 M Storage


2001 8 23


2001 8 23

Effective Use Of Sediment Quality Guidelines: Technical and Regulatory Decisions

Overview

1. There is a need for a formal universally accepted framework for sediment assessment
2. SQGs can be effectively used as a screening level assessment tool – they can also be misleading when used without supporting data
3. Review of lessons learned from process of development of water quality criteria
4. Path forward

Sediment Assessment Involves Two Key Decisions

1. Technical Decision

   - is there biological impairment due to contaminants?

2. Regulatory Decision

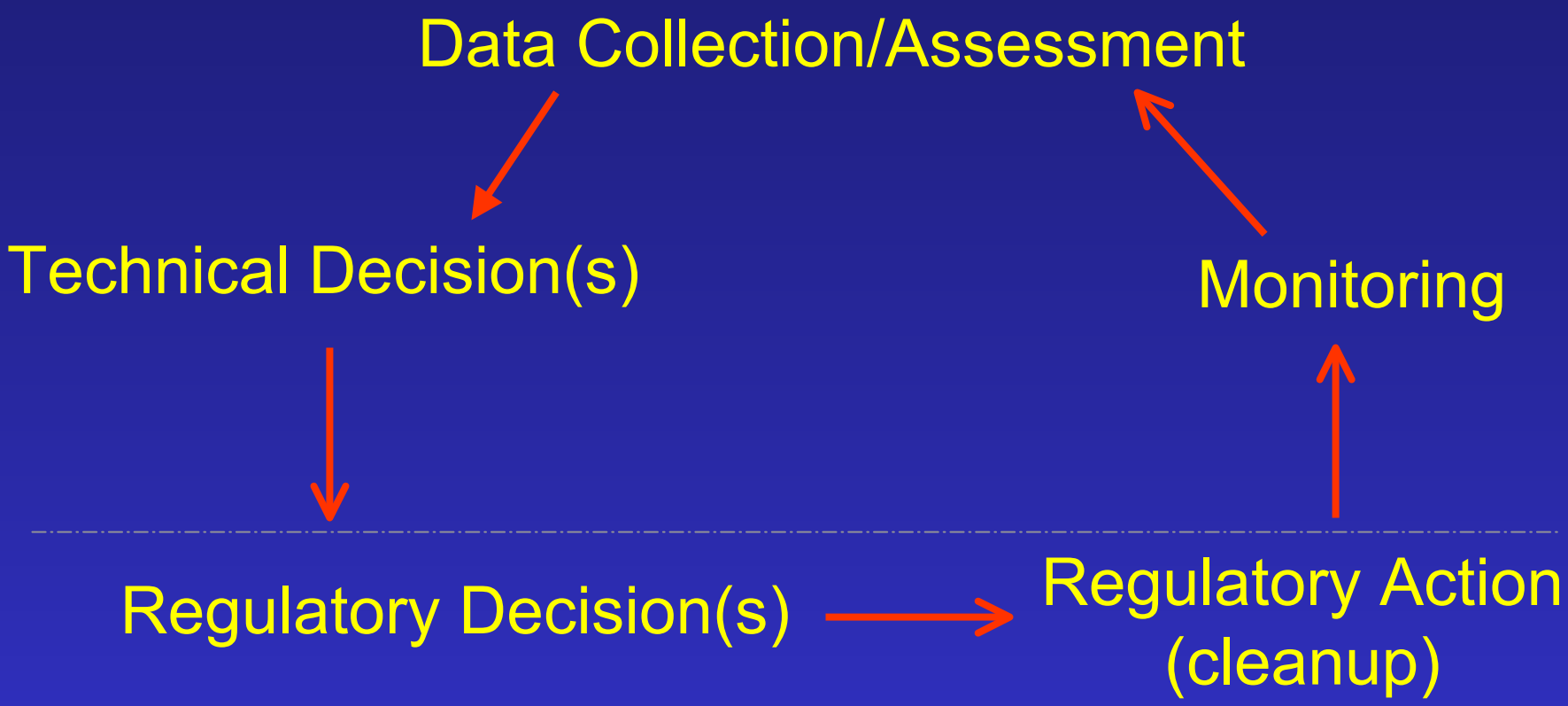
   - do the contaminants need to be removed?

Sediment Assessment Involves Two Key Decisions

- Underlying assumption to both Technical and Regulatory Decisions is that…….. good science will be the primary driver!

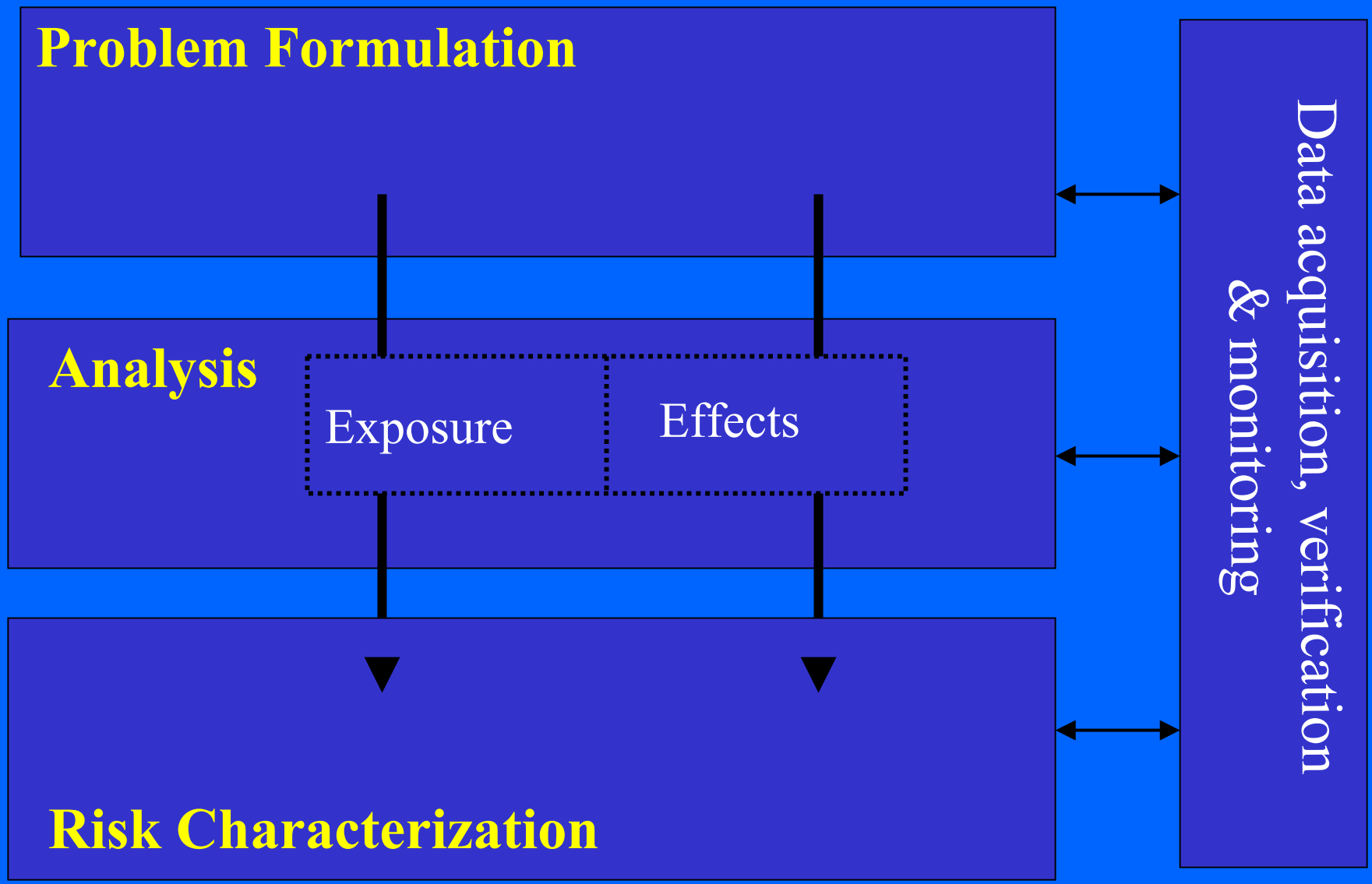
  Reasonable expectation but ……. Regulatory / risk management decisions always involve, social, political and economic considerations

Sediment Assessment Process



Process mimics the EPA ecological risk assessment approach

Ecological Risk Assessment Framework*

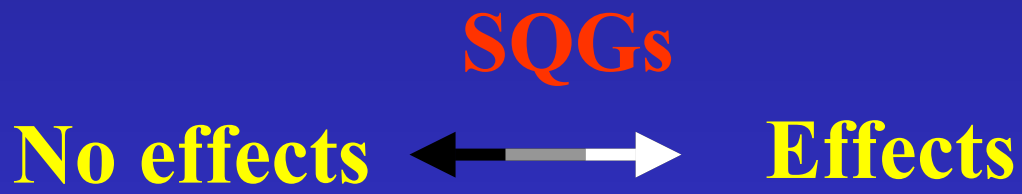


* USEPA Ecological Risk Assessment Framework (EPA, 1992)

Sediment Assessment: Technical and Regulatory Decisions

Technical Decisions

- SQGs frequently serve as the fenceline between no-effects and effects



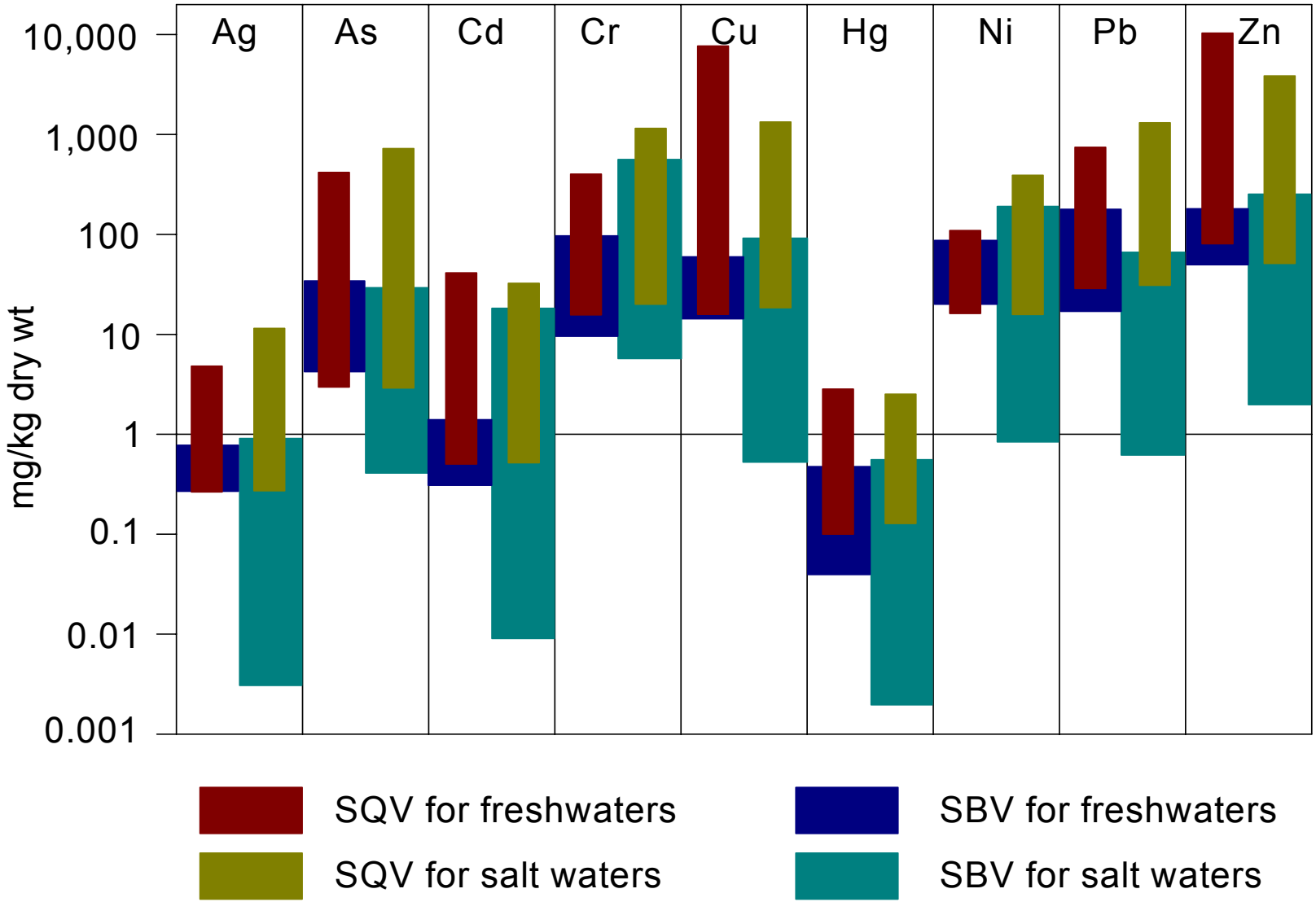
Sediment Assessment: Technical and Regulatory Decisions

Technical Decisions

- Use of SQGs always raises issues about the extent to which they are scientifically defensible

Example Follows:

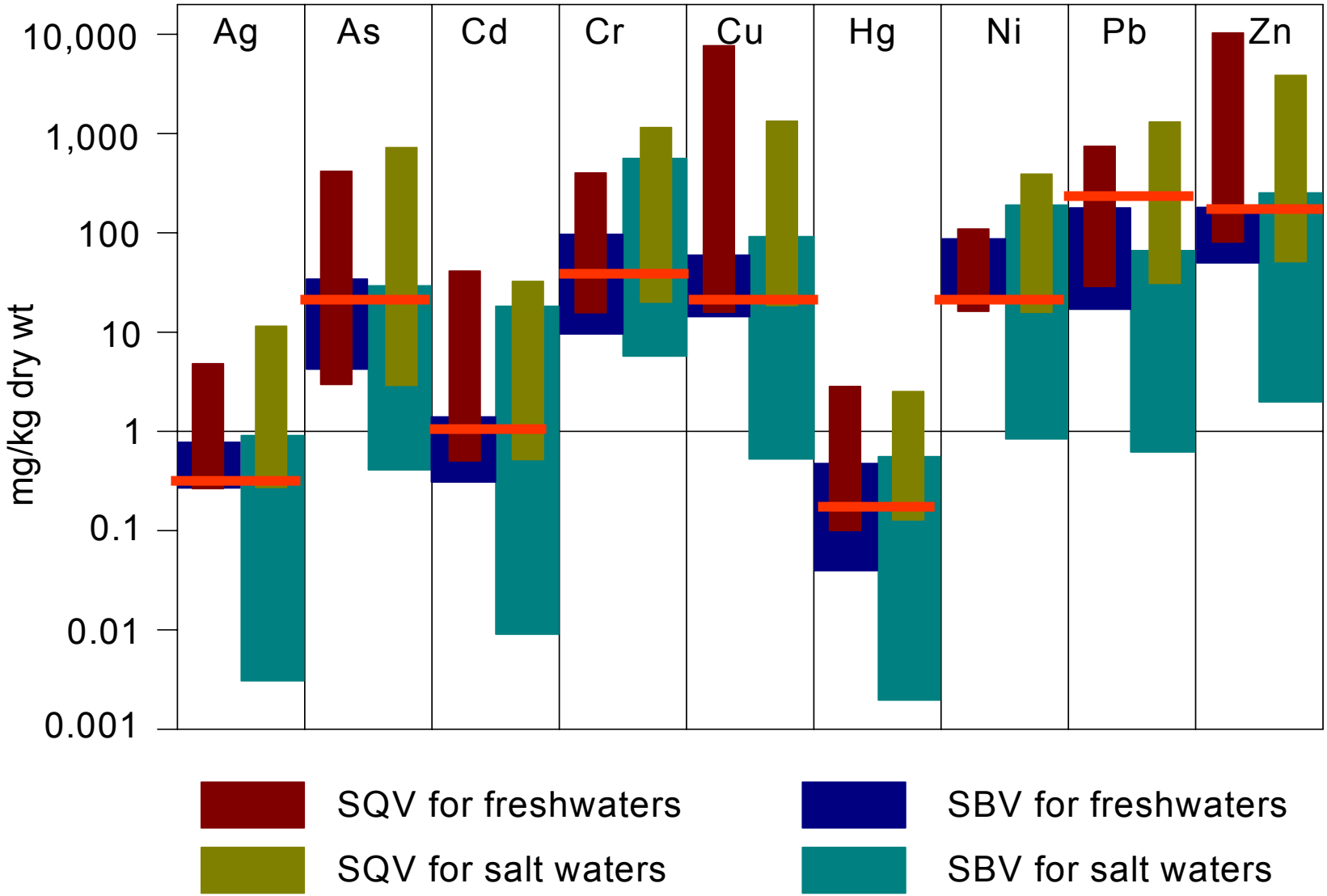
Worldwide Comparison of SQVs (SQGs) For Metals



Chapman et al. 2000

SBV = sediment background value

Comparison of SQVs (SQGs) On A Worldwide Basis For Metals With Maximum Background Concentrations*



*Indiana Dept. Environmental Management

Ratio Of Metals In Sediments of West Branch Grand Calumet River To Maximum Background

Calumet Site	Cd	Cr	Cu	Ni	Pb	Zn
UG-6	69	19	12	2	10	4
UG-7	49	16	14	8	12	40
UG-8	89	25	19	16	26	6
UG-9	52	18	27	17	13	4
UG-10	18	1.9	13	3	9	1

Sediment data from Giesy et al (1992) and Hoke et al. (1993)

Ratio Of Metals In Sediments of West Branch Grand Calumet River To ER-M Values

Calumet Site	Cd	Cr	Cu	Ni	Pb	Zn
UG-6	7.2	2.5	0.9	0.6	7.0	1.2
UG-7	5.1	2.2	1.0	3.1	8.3	12.8
UG-8	9.3	3.3	1.4	6.5	18.0	1.9
UG-9	5.4	2.4	2.0	7.0	8.8	1.1
UG-10	1.9	0.3	1.0	1.1	6.0	0.3

Sediment data from Giesy et al (1992) and Hoke et al. (1993)

Concentrations Of metals In Sediment Pore Water From Grand Calumet River Values (ug/L)

Calumet Site	Cd	Cr	Cu	Ni	Pb	Zn
UG-6	<0.01	<0.01	0.007	<0.1	<0.02	**0.49**
UG-7	<0.01	<0.01	**0.07**	<0.1	**0.03**	0.08
UG-8	<0.01	<0.01	0.008	<0.1	**0.04**	0.07
UG-9	<0.01	<0.01	**0.025**	<0.1	**0.02**	0.11
UG-10	<0.01	<0.01	<0.005	<0.1	<0.02	0.028

Values exceed WQC

Sediment data from Giesy et al (1992) and Hoke et al. (1993)

Metal/AVS Ratios For Sediments From the Grand West Branch Calumet River

Calumet Site	Cd	Cr	Cu	Ni	Pb	Zn	SEM /AVS
UG-6	<0.03	0.9	0.2	0.03	0.4	0.4	**1.9**
UG-7	0.005	0.02	0.07	0.03	0.1	0.9	**1.3**
UG-8	0.01	0.3	0.008	0.07	0.2	0.1	0.8
UG-9	0.001	0.03	0.02	0.01	0.02	0.01	0.09
UG-10	0.001	0.012	0.03	0.01	0.04	0.01	0.1

Metal concentration exceeds AVS

Sediment data from Giesy et al (1992) and Hoke et al. (1993)

Sediment Bioassays (*C. tentans*, *D. magna*, *C. dubia*, Microtox®)

Calumet River Site	Toxicity Observed In All Four species
UG-6	3/4
UG-7	2/4
UG-8	4/4
UG-9	4/4
UG-10	4/4

Sediment data from Giesy et al (1992) and Hoke et al. (1993)

Calumet River
Sediment Assessment

- Different conclusions would be reached at at different stages of the assessment - argues for a weight of evidence approach with field confirmation, i.e.,

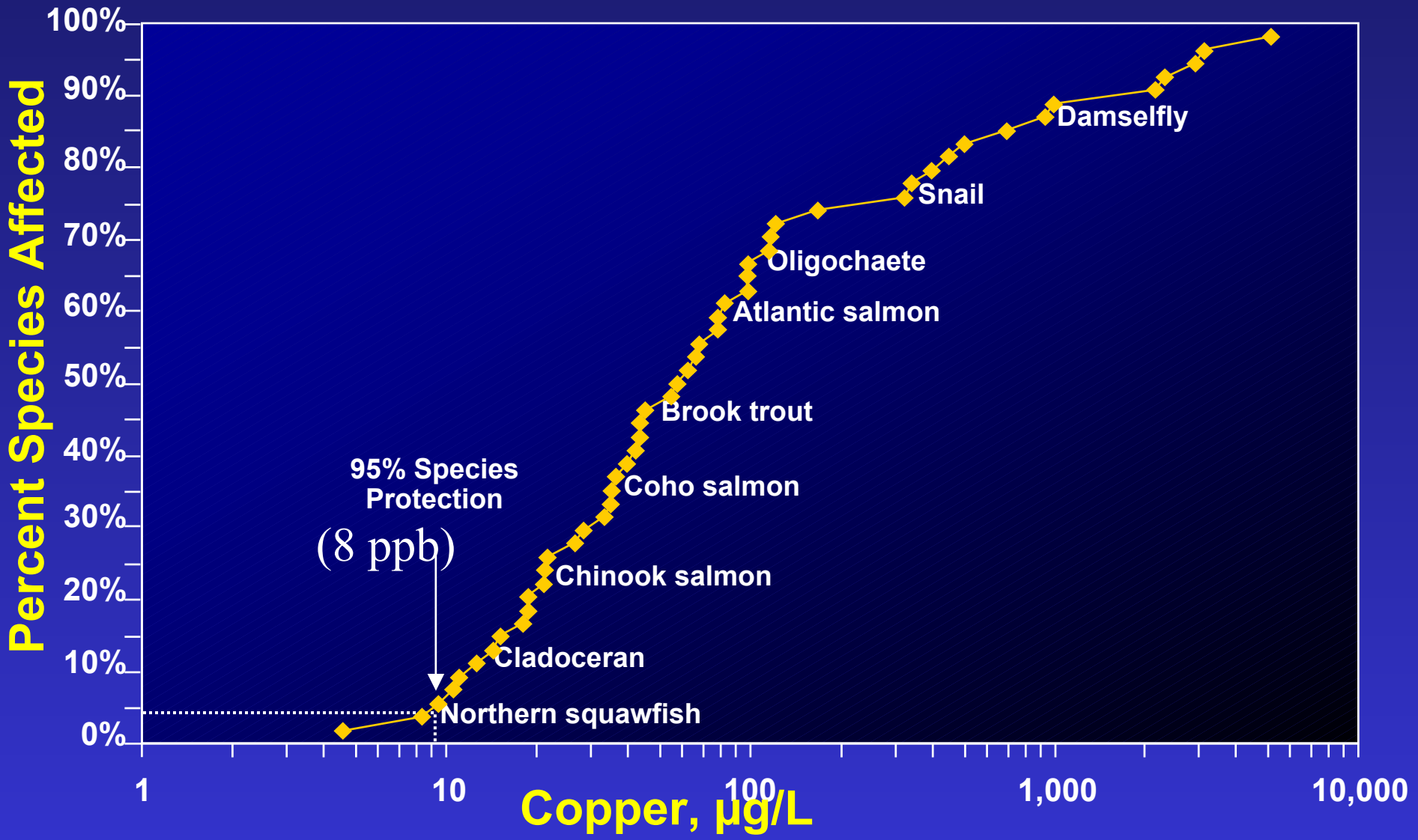
  - laboratory bioassays showed the sediments to be highly toxic
  - field infaunal measurements confirmed laboratory results
  - metal ERMs were exceeded, but porewaters and AVS-SEM were generally ok & species most sensitive to metal were not effected at sites with SEM > AVS
  - toxicity identification studies were not performed

Sediment Assessment: Technical Decisions

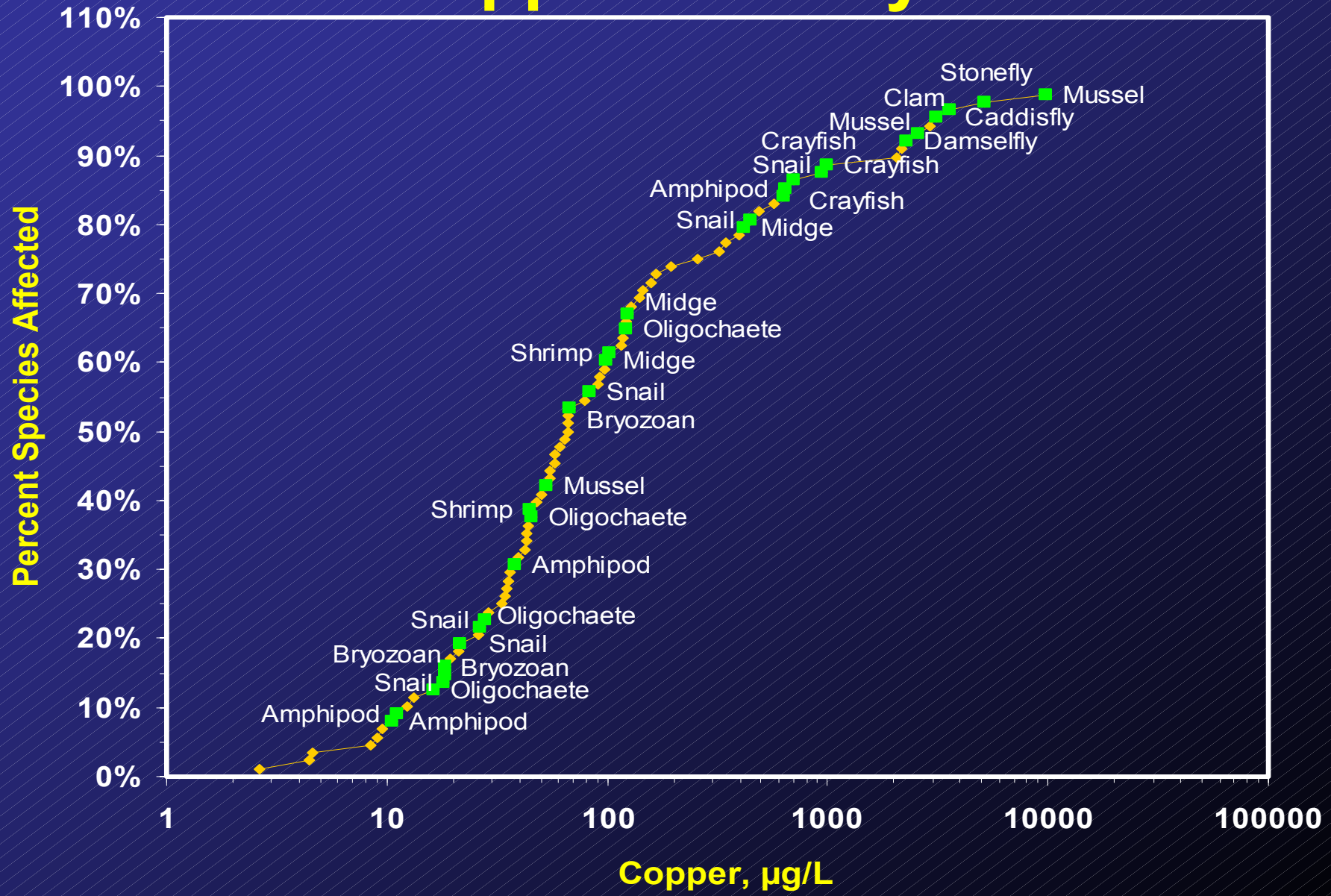
Lessons Learned From Water Quality Criteria

- 1985 EPA formalized an approach to WQC derivation
  - -Stephan et al. (1985)
  - - 8 acute values, 3 chronic for both fresh and salt water
  - - Formalized the approach to species sensitivity
  - - Established concept of species sensitivity distributions
- Adopted in many countries world-wide
- Adopted in risk assessments for establishing PNECs

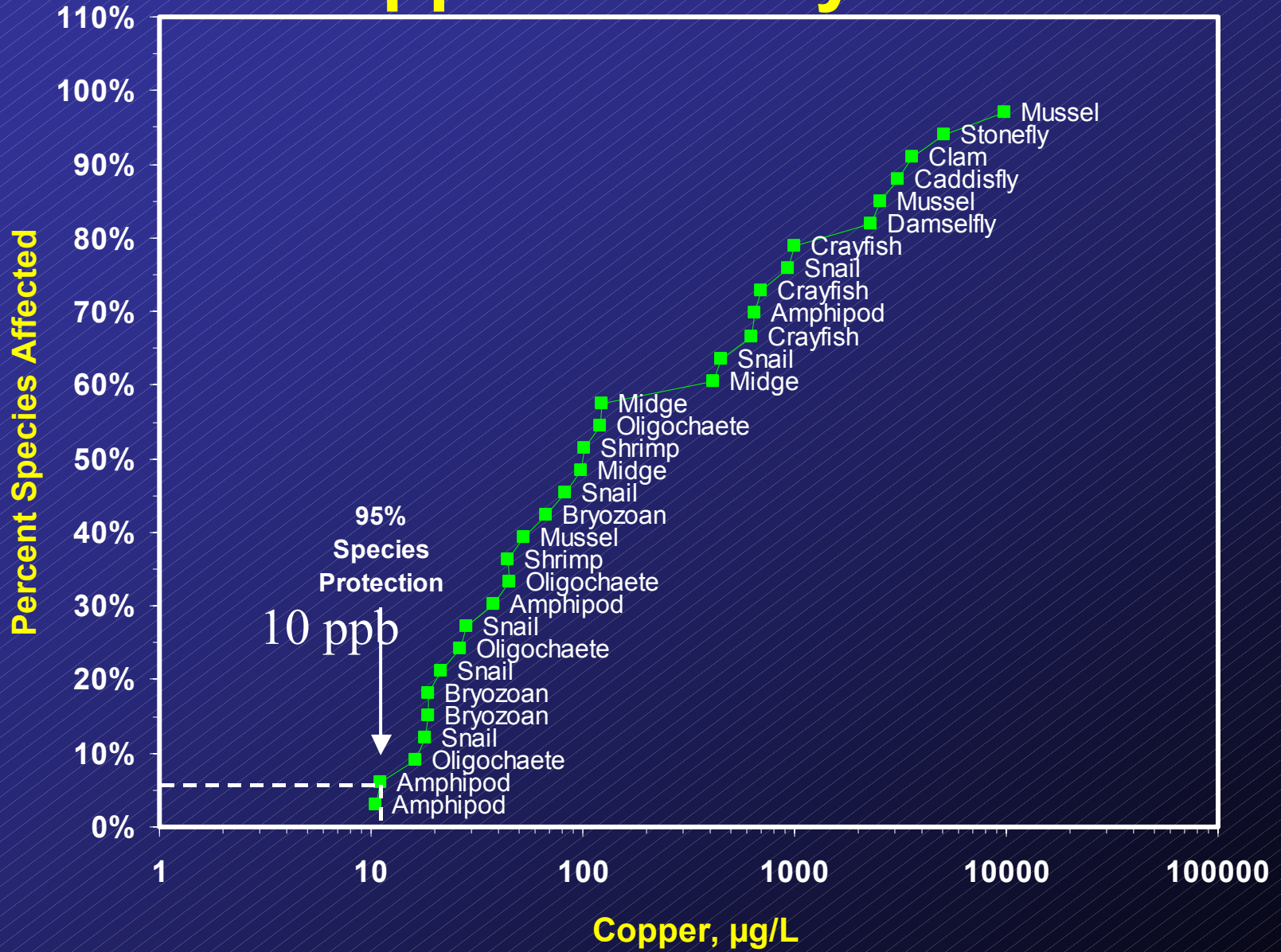
Graphical Representation of Acute Toxicity for Copper



Graphical Representation of Acute Copper Toxicity

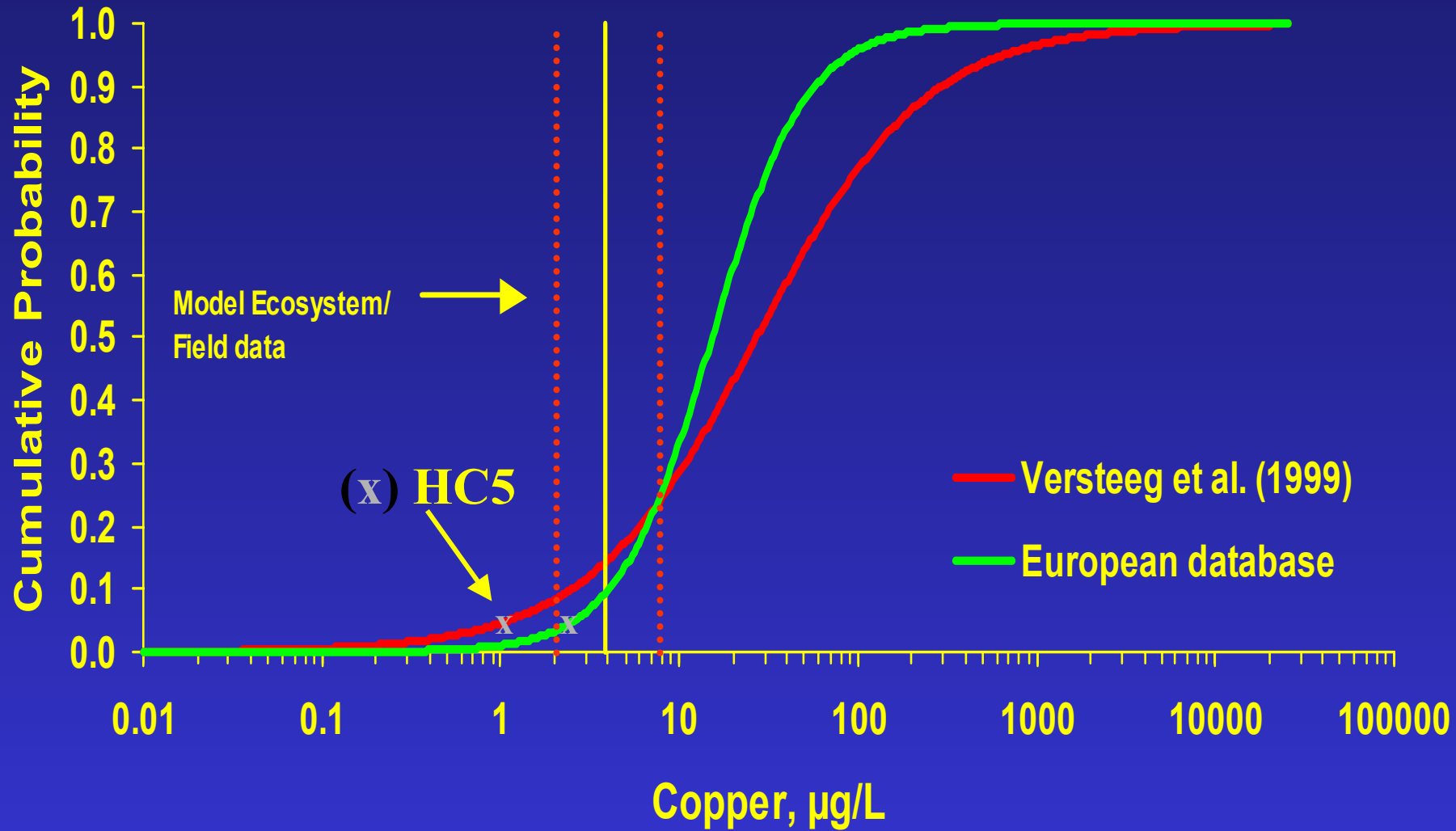


Graphical Representation of Acute Copper Toxicity to Benthos



Lab versus Field – Copper

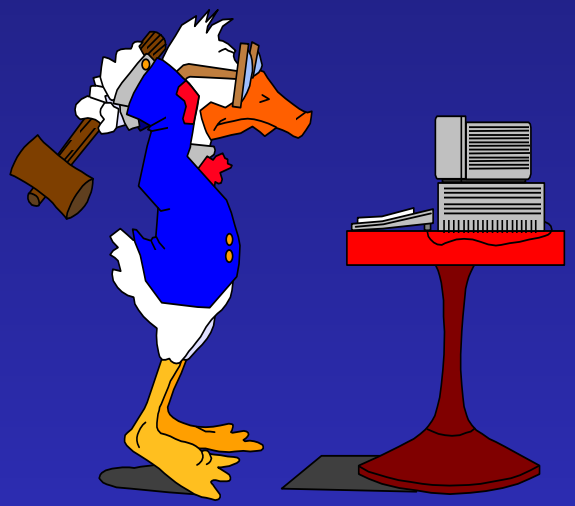
Adapted from Versteeg et al. (1999)



Sediment Quality Assessment

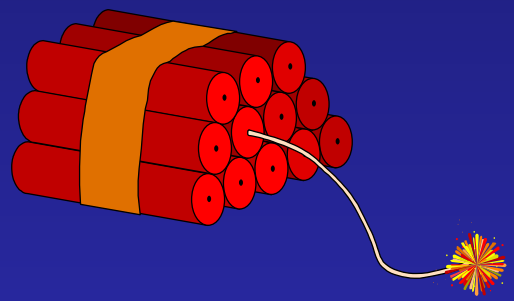
Is the system broke?

No!



Sediment Quality Assessment

"Where do we go from here? "

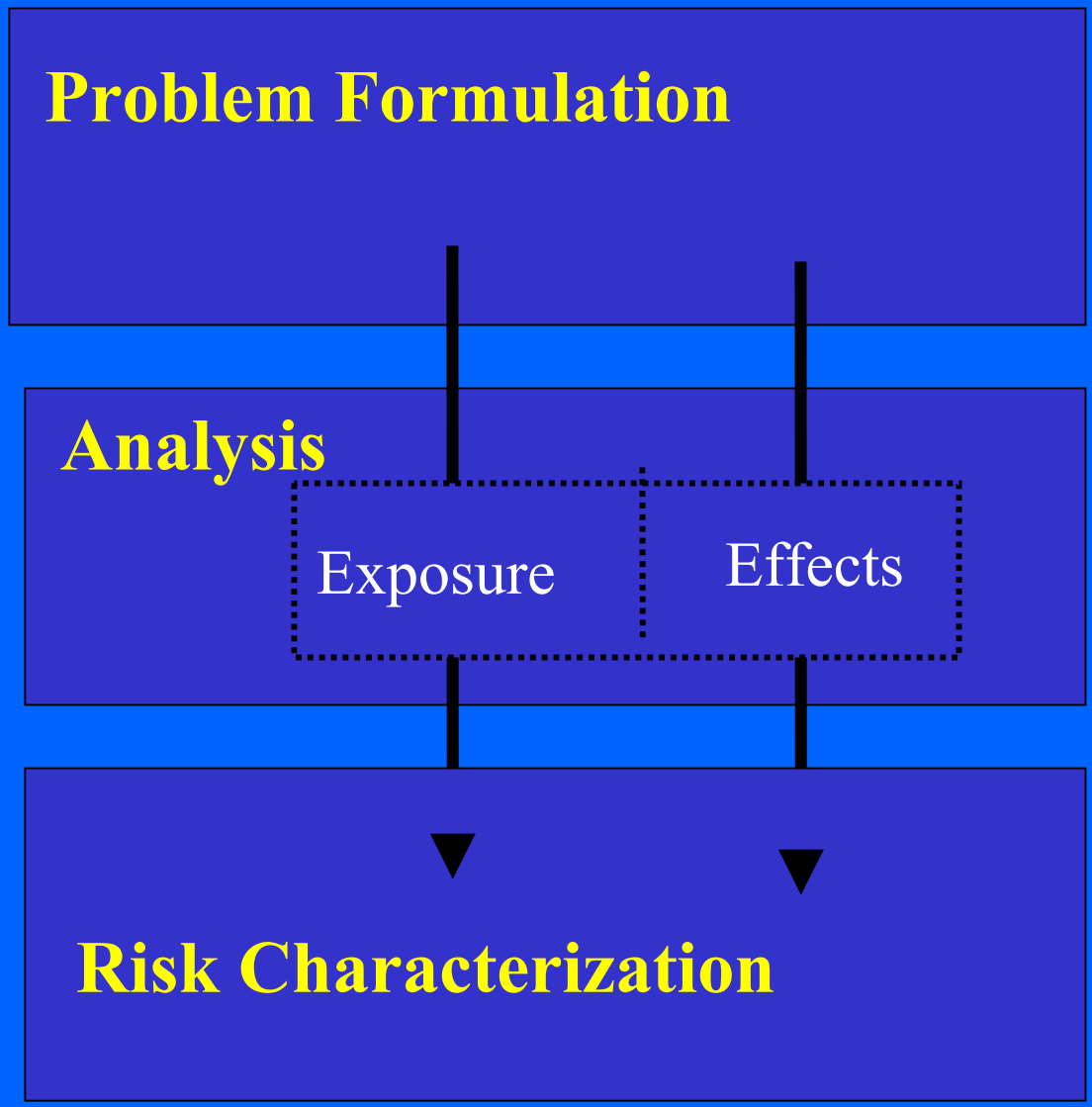


<u>Recommendation</u>

A formal process needs to be developed with:

- state of the art tools &
- weight of evidence approach to decision making

Ecological Risk Assessment Framework*



Superfund

Superfund utilizes ecorisk assessment but ... has not formalized the process for sediment assessment

* USEPA Ecological Risk Assessment Framework (EPA, 1992)

The Tools Exist

Published Methods for Conducting Sediment Toxicity Tests*

Test Description	Reference
Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates.	EPA/600/R-99/064
Standard Guide for Conduction 10-day Static Sediment Toxicity Tests with Marine and Estuarine Amphipods	ASTM E 1367-92
Standard Guide for Collection, Storage, characterization, and Manipulation of Sediments for Toxicological Testing	ASTM E 1391-94
Standard Guide for Designing Biological Test with Sediments	ASTM E 1525-94a
Standard Test Methods for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater invertebrates	ASTM E 1706-95b
Standard Guide for Conduction Sediment Toxicity Tests with Marine and Estuarine Polychaetous Annelids	ASTM E 1611
Standard Guide for Determination of Bioaccumulation of Sediment-Associated Contaminants by Benthic Invertebrates	ASTM E 1688-00
Acute Test for Sediment toxicity Using Marine and Estuarine Amphipods	EPS 1/RM/26
Test for Survival and Growth in Sediment Using Freshwater Midge Larvae *Chironomus tentans* or *riparius*	EPS 1/RM/32
Test for Survival and Growth in Sediment Using Freshwater Amphipod *Hyalella azteca* I	EPS 1/RM/33
Test for Survival and Growth for Sediment Using a Marine Polychaete Worm	EPS 1/RM
Reference Method for Determining Acute Lethality of Sediments to Estuarine or Marine Amphipods	EPS 1/RM/35
Reference Method of Determining Sediment Toxicity Using Luminescent Bacteria	EPS 1/RM
Sediment-Water Chironomid Toxicity Test Using Spiked Sediment	218
Sediment-Water Chironomid Toxicity Test Using Spiked Water	219

*Adams and Rowland 2002

Conceptual Sediment Assessment Framework

Conceptual Approach

TIER I **Screening Level**	TIER II **Preliminary Risk-Based Assessment**	TIER III **In-Depth Risk-Based Assessment**
•Minimal Data	• Spatial temporal contaminant measurements	• In-depth analytical assessment
• Limited exposure Assessment - TOC - AVS	• Acute/chronic toxicity assessment • Porewater tests • Elutriate tests	• Chronic sediment toxicity • Benthic population analysis • Resident species tests
• Limited biological testing	• Bioaccumulation measurements	• Bioaccumulation modeling
• Source identification	• Sediment TIE performed	• Trophic transfer of substances
• **SQGs**	• Limited site modeling • Benthic population evaluation - rapid sediment characterization • SPMDs / In situ testing • Transport/suspension measures • Biomarkers • Biodegradation	• Site specific detailed modeling • Full field evaluation with reference site comparison • Caged mussels / fish • Transport/suspension models • Histopathology • Natural Attentuation

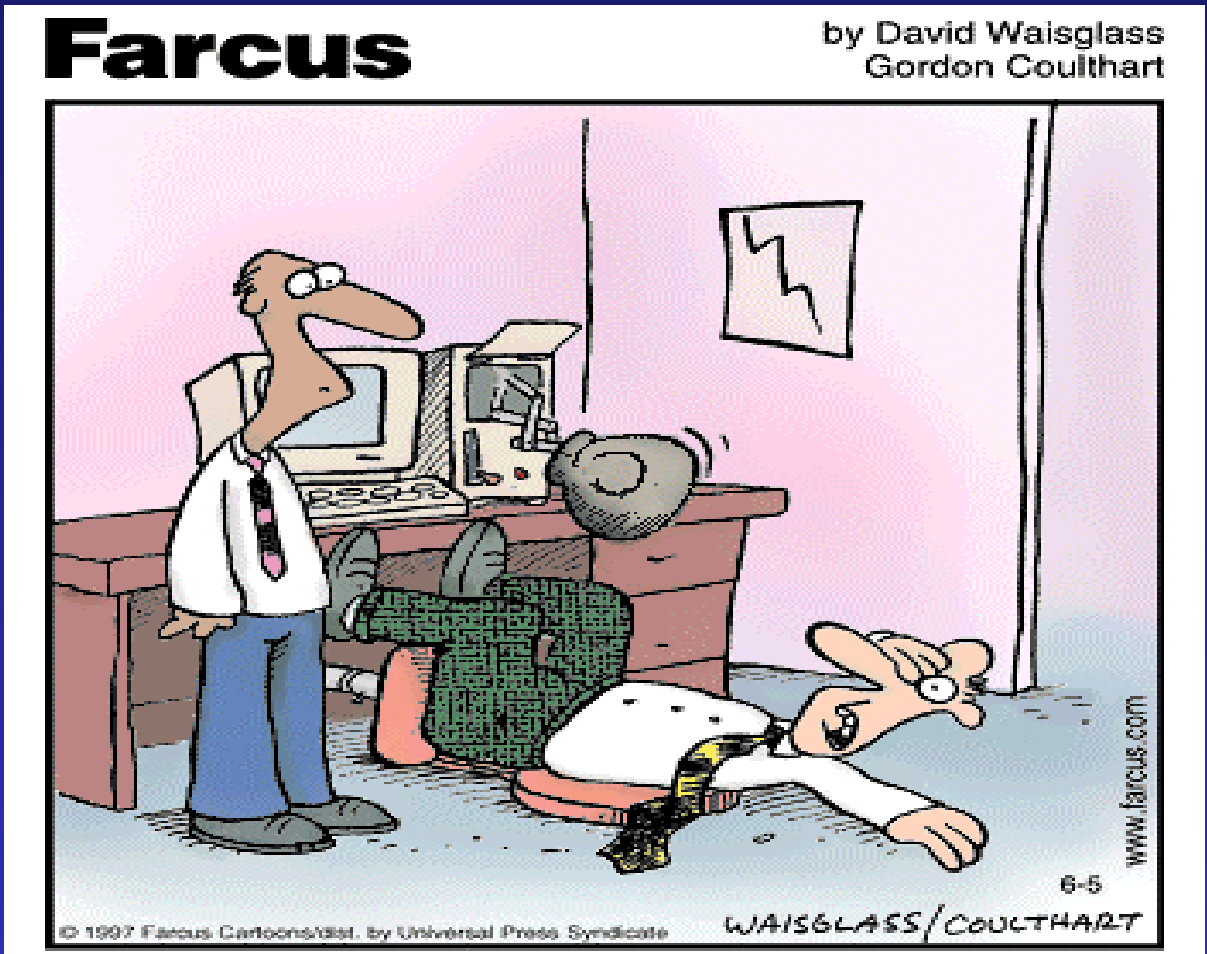
Time, Complexity, and Cost ⟶

Sediment Assessment: Technical And Regulatory Decisions

Recommendations

1. **Move the regulatory focus away from SQGs**
2. **Develop an integrated approach to assessing biological impairment**
3. **Formalize the approach through the peer review process**
   - **emphasis should be on the process not specific tests or endpoints**
   - **build upon the strengths of eco-risk assessment guidelines**
   - **utilize the lessons learned in the WQC approach**
4. **Develop a formal process for making remedial decisions and choosing alternatives**

END



The last thing I remember was saying something about SQGs and remediation ...